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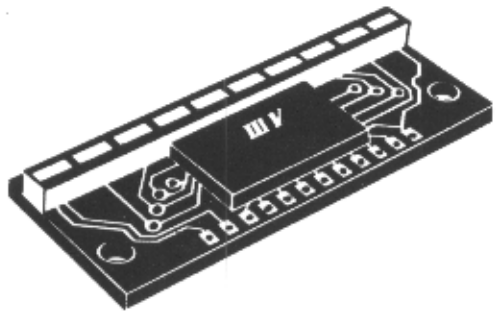
THREE-FIVE SYSTEMS, INC.

INTEGRATED BAR GRAPH DISPLAYS

TSM3914/15/16 SERIES



PRODUCT MATRIX

Part Number	Function	Segment Color Designation
TSM3914	Linear	10 Standard Red
TSM39142	Linear	10 Green
TSM39143	Linear	10 Yellow
TSM39146	Linear	6 Green, 4 Red
TSM39147	Linear	8 Green, 2 Red
TSM39148	Linear	6 Green, 2 Yellow, 2 Red
TSM3915	Logarithmic	10 Standard Red
TSM39151	Logarithmic	10 High Efficiency Red
TSM39152	Logarithmic	10 Green
TSM39153	Logarithmic	10 Yellow
TSM39158	Logarithmic	6 Green, 2 Yellow, 2 Red
TSM3916	VU	10 Standard Red
TSM39162	VU	10 Green
TSM39163	VU	10 Yellow
TSM39168	VU	6 Green, 2 Yellow, 2 Red
TSM39169	VU	7 Green, 3 Red

ABSOLUTE MAXIMUM RATINGS

Power Dissipation-Driver (Note 1):	500mW
V^+ Voltage:	24V
V_{LED} Voltage:	24V
Input Signal Overvoltage (Note 2):	±35V
Voltage on Resistor String:	-100mV to V^+
Reference Load Current:	10mA
Signal Input Current (With Overvoltage Applied):	±3.0mA
Operating Temperature Range:	0°C to +70°C
Storage Temperature Range:	-20°C to +70°C
Lead Temperature Range (Soldering, 5 Seconds):	230°C

FEATURES

- Packages are End-Stackable up to 10 Cascaded Arrays (100 Bar Graph Elements)
- Linear, Logarithmic, and VU Meter Functions
- Bar or Dot Display Mode Externally Selectable
- LED Current Programmable from 2.0mA to 30mA
- Stable, Internal Voltage Reference for Full-Scale Analog Inputs from 1.2V to 12V
- Inputs Operate Down to Ground
- Signal Input Withstands 35V Without Damage or False Outputs
- Variety of Green/Yellow/Red Bar Sequences Available

APPLICATIONS

- Power Meter in Stereo Systems
- S Meter in Ham and CB Radios
- VU Meter in Tape Recorders
- Process Control Meters
- Replacement for Edge Meters

DESCRIPTION

The TSM3914/15/16 series are functional replacements for a variety of conventional meters. Each combines a 10-element LED array and a monolithic integrated circuit display driver. Successive LEDs light as the analog input voltage level increases past prescaled threshold points.

The TSM3914 provides a linear analog display, with internal threshold points linearly scaled. A logarithmic display is provided by the TSM3915 with threshold points set on 3dB intervals. The TSM3916 is a variation of the logarithmic display; the VU meter function is provided by using threshold points at common VU intervals.

The driver circuit contains an adjustable voltage reference which precisely sets LED thresholds. Current drives to the LEDs are regulated and programmable, eliminating the need for resistors. The entire display can operate from supply voltages as low as 3V and as high as 24V. The internal voltage reference is also connected to an accurate 10-step voltage divider, supplying reference voltages for 10 individual comparators. These comparators switch as the signal voltage exceeds the established thresholds as described above. The typical overall inaccuracy (deviation from ideal) is typically within 1% for the TSM3914 and below 1dB for the TSM3915 and TSM3916. A high impedance input buffer accepts signals down to ground, yet protects against signal inputs of 35V above or below ground. A single (mode) pin changes the display from a bar graph to a moving dot.

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I_{LED}	LED Current/Segment	IL_{REF} = 1.0mA		10		mA
λP	Peak Wavelength Red High Efficiency Red Green Yellow			 655 635 565 585		 nm nm nm nm

Note 1: Driver dissipation is given by: $P_{DR} = (V_{LED} - 1.7V)\ I_{LED}$ (Total) + (V_V+) 10mA where V_{LED} is the LED supply voltage. 1.7V is the nominal individual LED voltage drop and 10mA is the maximum current of the V⁺ supply.

Note 2: The addition of a 39k resistor in series with the input signal allows ±100V signals without damage.

Note 3: Unless otherwise stated, all specifications apply with the following conditions: V⁺ (supply) 3.0V to 20V; input signal range 0.015V to (V⁺ -1.5V) with a maximum of $12V_{DC}$; Comparator divider voltages, same limits; $T_A = 25°C$; Reference load current, 80µA minimum.

Note 4: The following situations can lead to incorrect operation (a) V_{LED} exceeding V⁺ or more than 14V below V⁺; (b) signal and comparator divider voltage becoming higher than the limits of Note 1; (c) reference load capacitance above 0.05µF; (d) reference current loading above 5.0mA.

Note 5: Divider non-linearity is measured with R_{LO} at 0.000V and R_{HI} at 10,000 V_{DC}. (At lower divider voltages, buffer and comparator offset voltages may add significant error.)

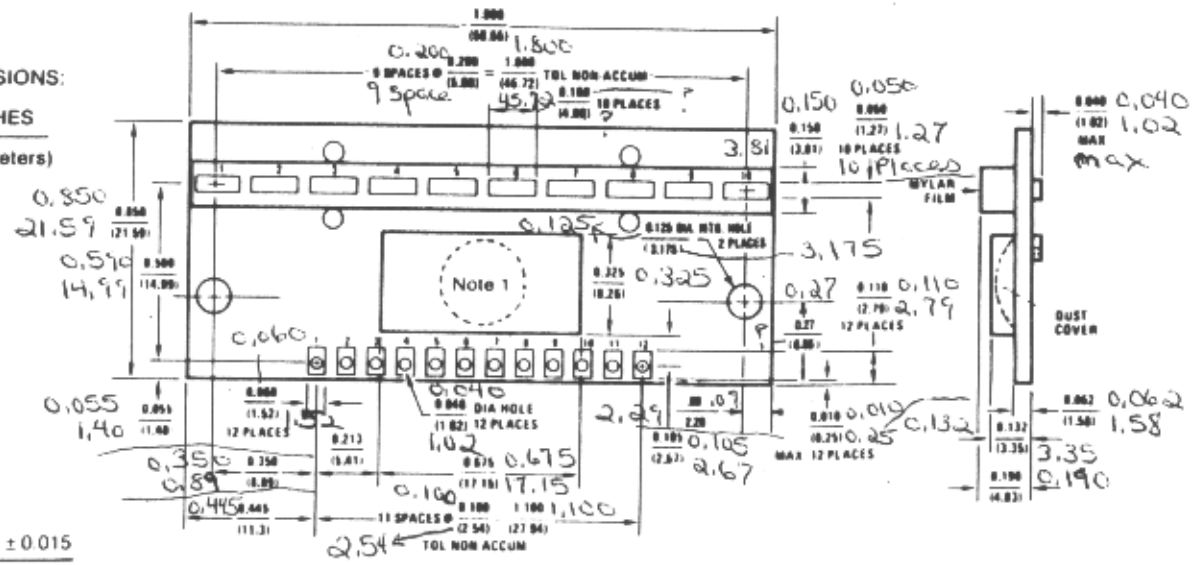
Note 6: Accuracy is measured referred to 0dB = 10,000 V_{DC} at signal input, with R_{LO} at 0.000V and R_{HI} at 10,000 V_{DC}. (At lower full-scale voltages, buffer and comparator offset voltages may add significant error.)

Note 7: Accuracy is measured referred to 3dB = 10,000 V_{DC} at signal input, with R_{LO} at 0.000V and R_{HI} at 10,000 V_{DC}. (At lower full-scale voltages, buffer and comparator offset voltages may add significant error.)

PHYSICAL DIMENSIONS

PIN	ELECTRICAL CONNECTION
1	V_{LED}
2	LED 1
3	GROUND
4	V⁺
5	R_{LO}
6	SIGNAL IN
7	R_{HI}
8	REFERENCE OUT
9	REFERENCE ADJUST
10	MODE
11	LED 9
12	LED 10

DIMENSIONS: INCHES / (Millimeters)



WEIGHT: 0.12 Ounce / 3.40 Grams

TOLERANCES: 0 XXX ±0.015 / (X.XX ±0.38)

Note 1: Standard package is provided with a rectanglular dust cover or Epoxy blob.

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OPTOELECTRICAL CHARACTERISTICS

Symbol	Parameter		Conditions T_A = 25°C	Min	Typ	Max	Units
V_{REF}	Voltage Reference Output		0.10mA ≤ I_{LREF} ≤ 4.0mA, V^+ = 12.0V, V_{LED} = 4.5V	1.2	1.28	1.34	V
I_I	Signal Input Bias Current		0V ≤ V_{IN} ≤ V^+ - 1.5V		25	100	nA
I_S	Supply Current (V^+ Lead)		V^+ = 5.0V to 20V, I_{LREF} = 1.0mA		6.0	10	mA
	Absolute Accuracy at each Threshold Point	TSM3914	Deviation from Straight Line through First and Last Threshold Point (Note 5)	-5.0		5.0	%
		TSM3915	V_{IN} = -3.0 to 18dB (Note 6) V_{IN} = -21 to -27dB (Note 6)	-1.0 -2.0		1.5 2.0	dB dB
		TSM3916	V_{IN} = +3.0 to -7.0dB (Note 7) V_{IN} = -10 to -20dB (Note 7)	-1.0 -2.0		1.5 2.0	dB dB
I_L	LED Segment Intensity Red High Efficiency Red Green Yellow		V^+ = 12.0V, V_{LED} = 4.5V, I_{LREF} = 1.0mA	 0.10 0.50 0.60 0.60	 0.20 0.80 1.50 1.50		 mcd mcd mcd mcd
	LED Intensity Matching (All Segments On)		V_{IN} ≥ 10V, V^+ = 12V, V_{LED} = 3.0V, I_{LREF} = 1.0mA		±33		%
I_{LED}	LED Current/Segment		V^+ = 12V, V_{LED} = 4.5V, I_{LREF} = 1.0mA		10		mA
λP	Peak Wavelength Red High Efficiency Red Green Yellow				 655 635 565 585		 nm nm nm nm

Note 1: Driver dissipation is given by $P_{DR} = (V_{LED} - 1.7V)\ I_{LED}$ (Total) + (V_+) 10mA where V_{LED} is the LED supply voltage. 1.7V is the nominal individual LED voltage drop and 10mA is the maximum current of the V+ supply.

Note 2: The addition of a 39k resistor in series with the input signal allows ±100V signals without damage.

Note 3: Unless otherwise stated, all specifications apply with the following conditions: V+ (supply) 3.0V to 20V; input signal range 0.015V to (V+ -1.5V) with a maximum of $12V_{DC}$; Comparator divider voltages, same limits; T_A = 25°C, Reference load current, 80µA minimum.

Note 4: The following situations can lead to incorrect operation (a) V_{LED} exceeding V+ or more than 14V below V+; (b) signal and comparator divider voltage becoming higher than the limits of Note 1; (c) reference load capacitance above 0.05µF; (d) reference current loading above 5.0mA.

Note 5: Divider non-linearity is measured with R_{LO} at 0.000V and R_{HI} at 10,000 V_{DC}. (At lower divider voltages, buffer and comparator offset voltages may add significant error.)

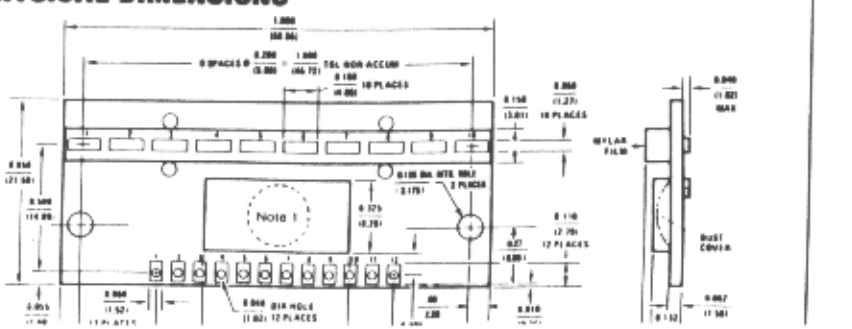
Note 6: Accuracy is measured referred to 0dB = 10,000 V_{DC} at signal input, with R_{LO} at 0.000V and R_{HI} at 10,000 V_{DC}. (At lower full-scale voltages, buffer and comparator offset voltages may add significant error.)

Note 7: Accuracy is measured referred to 3dB = 10.000 V_{DC} at signal input, with R_{LO} at 0.000V and R_{HI} at 10.000 V_{DC}. (At lower full-scale voltages, buffer and comparator offset voltages may add significant error.)

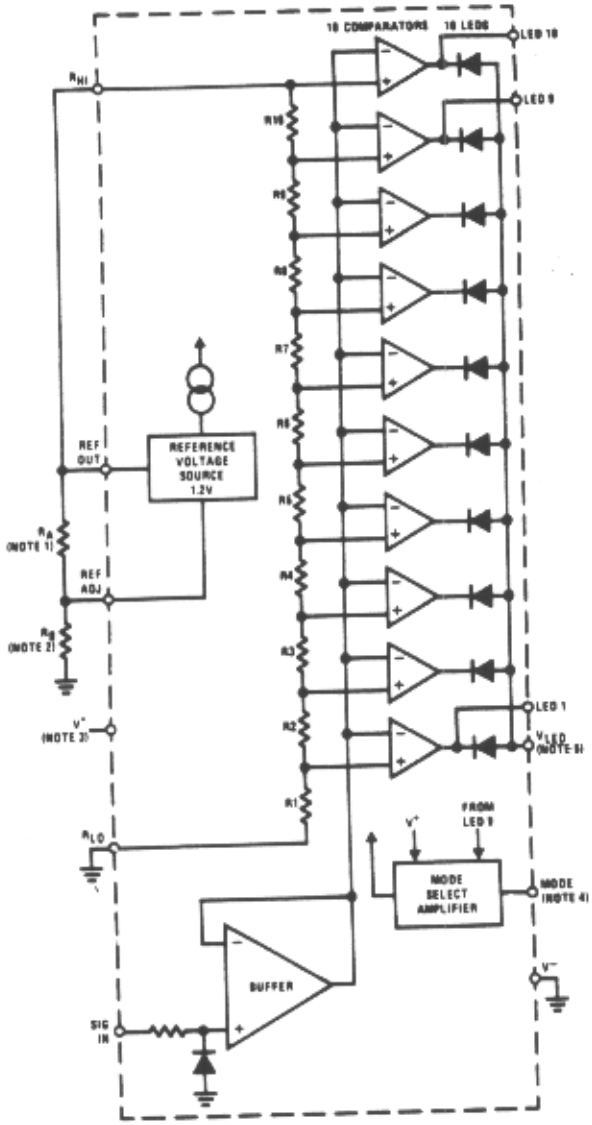
PHYSICAL DIMENSIONS

PIN	ELECTRICAL CONNECTION
1	V_{LED}
2	LED 1
3	GROUND
4	V^+
5	R_{LO}
6	SIGNAL IN
7	R_{HI}
8	REFERENCE OUT
9	REFERENCE ADJUST
10	MODE

DIMENSIONS:
INCHES
(Millimeters)



BLOCK DIAGRAM



TYPICAL RESISTOR STRING VALUES

RESISTOR	TSM3914	TSM3915	TSM3916
R1	1.00k	1.00k	0.708k
R2	1.00k	0.41k	1.531k
R3	1.00k	0.59k	0.923k
R4	1.00k	0.83k	0.819k
R5	1.00k	1.17k	1.031k
R6	1.00k	1.66k	1.298k
R7	1.00k	2.34k	0.769k
R8	1.00k	3.31k	0.864k
R9	1.00k	4.69k	0.970k
R10	1.00k	6.63k	1.087k
Total	10k	22.6k	10k

Note 1: R_A determines I_{LED} and thus LED brightness:

$$I_{LED} \cong 10 \left(\frac{1.25V}{R_A} + \frac{V_{FS}}{R_{DIVIDER}} \right)$$

Note 2: R_B determines full-scale voltage.

$V_{FS} \cong 1.25V \left(1 + \frac{R_B}{R_A}\right) + I_{REF} R_B$, where I_{REF} is nominally 80μA.

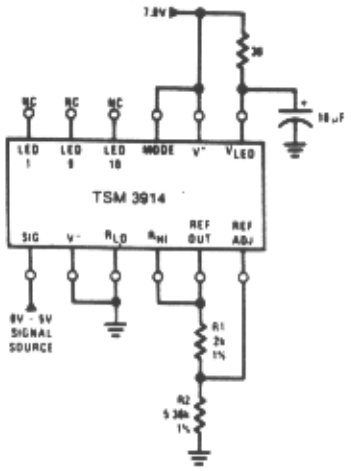
Note 3: V^+ may be 3.0V to 20V, additionally, for proper operation $V^+ \geq V_{LED}, \geq V_{SIG} + 1.5V, \geq V_{REF} + 1.5V$.

Note 4: Mode controls type of display. Connect to LED 9 for dot display and to V^+ for bar display.

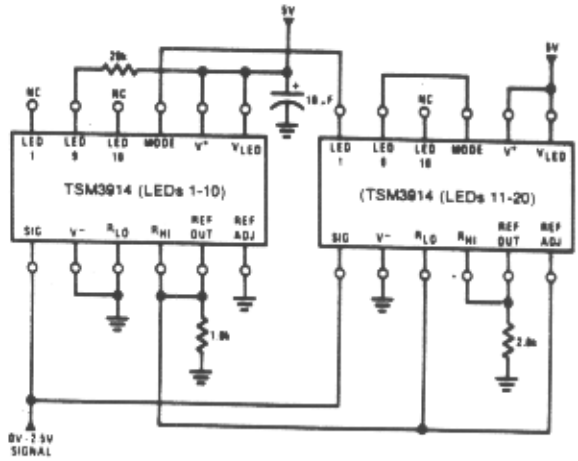
Note 5: V_{LED} may be 3.0V to 20V (see Note 3). V_{LED} may be limited by the driver circuit dissipation rating.

Note 6: Driver dissipation is given by $P_{DR} = (V_{LED} - 1.7V) I_{LED}$ (Total) + (V_V^+) 10mA where V_{LED} is the LED supply voltage, 1.7V is the nominal individual LED voltage drop and 10mA is the maximum current of the V^+ supply.

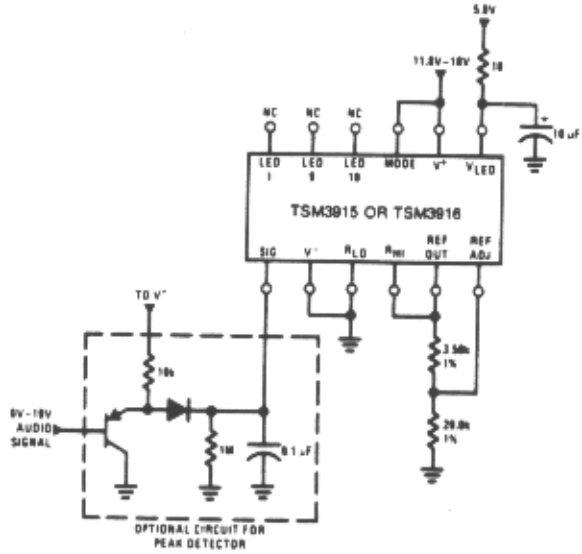
TYPICAL APPLICATIONS



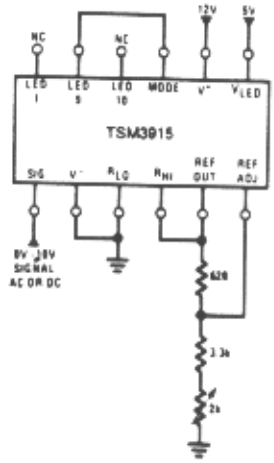
Linear Bar Graph (5V Full-Scale)



20-Segment Linear Dot Graph (2.5V Full-Scale)



Logarithmic (TSM3915) or VU (TSM3916) Audio Bar Graph



Logarithmic Audio Dot Graph (10V Full-Scale)

RECOMMENDED DISPLAY PROCESSING

The TSM3914/15/16 is constructed on a standard printed circuit board substrate and covered with a plastic reflector. The edge connector tab will withstand 230° C for 5 seconds. Permanent damage to the display will result if reflector temperature exceeds 70° C. Since the display is not hermetic, immersion of the entire package during flux and clean operation may cause condensation of flux or cleaner on the underside of the reflector. Only the edge connectors should be immersed.

Rosin core solder, solid core solder, and low activity organic fluxes are recommended. Freon TF, Isopropanol, Methanol or Ethanol solvents are recommended only at room temperature and for short periods. The use of other solvents or elevated temperature use of the recommended solvents may cause permanent damage to the reflector or display.

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